

CA20NEN 78D33

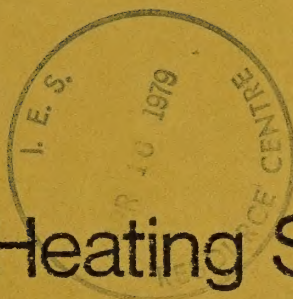
Ontario. Ministry of Energy.

DISTRICT HEATING SEMINAR: SUMMARY OF PROCEEDINGS. 1978.

CAONEN 78D33

Ministry
of
Energy
Ontario

3 1761 05688849 8



District Heating Seminar: Summary of Proceedings



June 1978

Earth Sciences Library

INST. FOR ENVIRONMENTAL STUDIES
UNIVERSITY OF TORONTO



3 1761 03883774 6

ONTARIO MINISTRY OF ENERGY
INFORMATION OFFICE
12th floor
56 Wellesley Street West
Toronto, Ontario
M7A 2B7

A limited number of copies of this report
are available free of charge through:

The Ontario Ministry of Energy
Information Office
12th floor
56 Wellesley Street West
Toronto, Ontario
M7A 2B7

DISTRICT HEATING SEMINAR

SUMMARY OF PROCEEDINGS

Sponsored by

The Ontario Ministry of Energy

Toronto, Ontario
Printed July 1978

TABLE OF CONTENTS

	<u>Page</u>
1. INTRODUCTION	1
2. DISTRICT HEATING FOR ONTARIO	2
- Hon. Reuben Baetz	
3. DISTRICT HEATING: WHERE WE STAND IN ONTARIO	6
- Dr. I.H. Rowe	
4. TRANSFER OF EUROPEAN EXPERIENCE IN DISTRICT HEATING TO ONTARIO	16
- Bruce A. Richardson	
5. THE TRANSFERABILITY OF SCANDINAVIAN CENTRAL DISTRICT HEATING SYSTEMS AND BUILDING CHARACTERISTICS TO THE ONTARIO CONDITION	31
- John Hix	
6. OPPORTUNITIES IN DISTRICT HEATING	52
- Fred W. Molland	
7. A GAS UTILITY'S VIEW OF DISTRICT HEATING	60
- G.E. Creber	
8. CLOSING REMARKS	66
- Dr. I.H. Rowe	
9. PANEL DISCUSSION	69

INTRODUCTION

On June 7, 1978, the Ministry of Energy held a seminar on district heating as part of its ongoing program to explore the potential of district heating as an alternative form of energy supply for homes and businesses in the Province.

About 100 persons attended the half-day session representing architectural, engineering, developer, and regulatory communities of interest. In addition, representatives of Nordic countries where district heating is an established practice attended.

The Honourable Reuben Baetz, Minister of Energy, opened the session. Other speakers were: Dr. I. H. Rowe, Executive Co-ordinator, Conservation and Renewable Energy, Ministry of Energy; Bruce A. Richardson, P. Eng., H. H. Angus and Associates Ltd.; John Hix, Architect and Planner, Hix Associates Ltd.; Fred W. Molland, Industrial Energy Consultant, Ministry of Industry and Tourism; and G. E. Creber, President, Consumers' Gas Co.

This report presents the texts of their remarks and the transcript of a brief panel discussion which followed.

Digitized by the Internet Archive
in 2025 with funding from
University of Toronto

"DISTRICT HEATING FOR ONTARIO"

The Honourable Reuben Baetz,
Minister of Energy

I'm pleased to be here this morning to welcome you to the Ministry of Energy's Seminar on District Heating.

It's very gratifying to see how many of you have accepted our invitation. While District Heating is an established practice in northern Europe and the Soviet Union, it is a relatively new concept here in Canada.

Europe's heavy dependence on relatively expensive, imported fuels has been the incentive for it to become involved in district heating. It helps to provide these countries with the fuel economy and flexibility they so badly need.

With fuel prices in Canada continuing to rise rapidly, we, too, are turning our attention to alternative energy sources, hence our interest in district heating.

District heating technology is tested and proved and is available to us. It can be applied in Ontario and we already have the manufacturing capability to make much of the equipment. And furthermore, a hot water distribution system is compatible with a variety of heat sources: for example, nuclear power stations, refuse incineration or solar collectors.

The seminar this morning is intended to explore with you some aspects of district heating, to give you a better understanding of its potential and to discuss some of the issues still to be resolved.

One major consideration, of course, is the fact that the cost of fossil fuels and electricity is still too low to make the development of conventional district heating schemes competitive on a wide scale in Ontario. But will that continue to be true in the future, and, if so, for how long?

Relative to other jurisdictions, our electrical costs are very low. For example: In Sweden, where district heating has expanded very rapidly in recent years, electricity for heating costs is roughly 4¢ to 5¢ per KWH, compared with an average cost of 2.8¢ per KWH in Ontario.

Electricity produced by the combined generation of electricity and hot water, using small back-pressure turbine generators which are compatible with district heating, cannot yet compete with electrical power generated by Ontario Hydro. Thus, the competitive economic environment for district heating in Ontario is quite different from Europe's.

We should also bear in mind the differences between our institutions and systems in Ontario and those in Europe.

Our social, legal, and administrative systems differ from those in Europe, and we must proceed carefully in order to set district heating within an environment appropriate to Ontario. The question of financing, of public or private ownership, and of such items as codes and standards also need to be considered and answers found.

Notwithstanding all of these differences, developments in both renewable and non-renewable energy are forcing us to re-examine our traditional roles, and it is certain that we will be making many changes in the years to come. Such changes will be beneficial only if they are carefully planned and introduced.

My Ministry is excited about the potential of district heating. We have initiated a series of studies over the past two years, and our understanding of the problems and opportunities grows daily. Central distribution systems already appear to be economically viable in developments with high heat loads, such as the St. Lawrence Housing Project in the City of Toronto.

The time has come to share our experience to date and to benefit from the ideas and talents of others. That is the main purpose of today's meeting.

It is a first step on what I hope is a fast track in the development of a new form of heating in this country.

Now I would like to call on Dr. Ian Rowe to begin today's program.

"DISTRICT HEATING - WHERE WE STAND IN ONTARIO"

I.H. Rowe
Executive Co-ordinator
Conservation & Renewable Energy
Ministry of Energy

Good morning. Thank you for giving your time to this seminar on district heating. It is the belief of this Ministry that district heating is a technology whose time has come, but what it will take is commitment from all the players involved: engineers, architects, planners, developers, regulatory bodies, financing institutions.

Many of you are already knowledgeable about district heating. But let me briefly review some essential points. District heating is very simple in concept. A central source of heat, a distribution system and a means of heat exchange in individual houses or commercial buildings are the main components. The distinction between a central heating system that serves, say, a number of university buildings, and a full district heating system is not clear-cut, but basically a district heating system serves a large number of buildings and a variety of owners.

Why the interest in district heating? You will hear about many of its advantages and disadvantages during this seminar. From strictly an energy conservation point of view,

district heating offers an opportunity for a very large increase in the efficiency of providing electricity and heat. The efficiency of thermal generation of electric power -- whether nuclear or fossil-fired -- is physically limited to about 35%. As much as another 50% is usually dissipated as heat at relatively low temperatures. What is needed to make use of this 50% is an adequate heat load with the appropriate temperature requirements. District heating has been proving itself in Europe to be just such a heat load.

But we all know that nothing, at least nothing we want, comes for free. So what will district heating cost? Is it really economically feasible? Are the benefits worth the costs?

Let me approach this in a roundabout way. In 1929, at the Royal University of Technology in Stockholm, Sweden, it was suggested that all of Stockholm be serviced by combined electric power and district heating plants for the conservation reason that I have just outlined. Only in 1953 did district heating -- and then in the form of heat-only plants, rather than combined electric power and heat plants -- come to Stockholm. Today, district heating in Stockholm serves about 25% of the buildings with about 2.5 billion KWh of heat per year and about 180 MW of electric power from combined plants. Heat-only plants still dominate the pro-

duction of district heating. Even without the direct conservation benefits of combined heat and power production, the economics of district heating have been favourable, not only in Sweden, but in Denmark, Finland, Germany and eastern Europe as well. Consumers benefit from lower fuel costs. Municipalities suffer less air pollution, often have the flexibility to use several types of fuel for heating, and receive a profitable return on investment. The country benefits from increased domestic manufacturing and reduced imported fuel requirements. Clearly, energy conservation is only one of many reasons that district heating has expanded so rapidly in Europe.

In many European centres where fuel costs have consistently been higher than ours, the economic feasibility issue has long been resolved. But district heating takes time; time to plan and design, time to construct, time for heat loads to build up, time to receive payback and conservation benefits from investment. And we may well be running out of time. Most of the new construction for the rest of this century will occur in the next 15 years. The planning of our developments, whether in new areas or old, should include provision of central distribution systems where they are cost-effective.

Let me briefly describe what we at the Ministry see as the ingredients essential for the successful deployment of district heating in Ontario.

1. Understanding of the technology and institutional implications of district heating by all the professional communities involved in development of our urban areas. This is the reason for this seminar, and we hope the dialogue continues.
2. Commitment to conserving energy through the use of heat currently dissipated in the generation of electrical power or in refuse incineration. This is the major conservation benefit of district heating.
3. Assurance of favourable economics to all sectors involved: The user of heat, the owner and operator of the system, the provincial interest. Only if the economic interests of all three sectors are satisfied will district heating be feasible. In Sweden, more than 20 years ago, a public, written agreement between the Landlords' Association and the Tenants' Association specified that the maximum tariffs for district heating would be no higher than individual furnace operating costs.

This agreement has obviated the need for legislated tariffs. A similar type of assurance to Ontario consumers would be straightforward.

The owner and operator of a district heating system would require some assurance of an appropriate level of return on investment and some protection from rising fuel costs. Again, there is ample precedent in Ontario regarding energy supply utilities.

In light of Provincial interests, any reduction in the need for fossil fuels results in a decreased balance of trade deficit. Similarly, reduction in peak heating load requirements reduces the need for capital investment in physical plant dollars for fossil fuels and dollars for generating capacity are a major financial concern for Ontario. I should emphasize here that in comparing the economics of district heating, or of any conservation investment for that matter, with conventional practice, current average user costs of energy are generally assumed. The appropriate meter stick, however, is the replacement cost of new supply. Replacement costs, not average costs, are an accurate indication of the costs of satisfying in-

creased energy demands. In future years, the temporary gap between market prices of energy and replacement costs will undoubtedly vanish. Thus, conservation benefits of investments as currently estimated for projects such as district heating have been unduly conservative.

Of course, the Ontario government is also interested in the potential for job creation and manufacturing. Much of the equipment for district heating -- piping, valves, insulation, fan coil units -- is already being made in Ontario. The Ministry of Industry and Tourism has begun to look at the industrial spin-offs of district heating and will be reporting to you during this session.

4. Demonstration that district heating technology is here and now, that it works and is reliable. The best proof of this is the length of the waiting lists in all the European cities with recent systems; in Stockholm the list of waiting subscribers is 30% of the existing rolls. There are opportunities in Ontario for the pilot demonstration of the best technology developed -- all that's needed is a projected heat load of sufficient size and with a reasonable phasing to be

economic. The St. Lawrence redevelopment area in Toronto and several new, "green-field" opportunities come to mind. You will hear next from Bruce Richardson of H.H. Angus & Associates Ltd., whose firm has been recently commissioned to perform a preliminary engineering design for the proposed community of North Pickering. We do not believe that the potential of district heating in Ontario will be demonstrated conclusively one way or the other by any one, single case. As with everything else new, district heating will be demonstrated in a variety of circumstances and will be adapted to site-specific requirements.

In parallel with the demonstration in Ontario of tried and true hardware proved elsewhere, we need an ongoing program of technology improvement to make the equipment simpler, less expensive, and available through Canadian manufacturers. This is an area of joint Federal and Provincial responsibility.

5. Identification and removal of institutional barriers. District heating is as much an innovative form of social organization as a new technology in Ontario, and there are a number of regulatory, legislative, jurisdictional and administrative

issues involved. Currie, Coopers and Lybrand Ltd. is currently conducting a study for the Ministry of Energy of these issues and their relation to private sector ownership and operation. Municipalities would also be intimately involved, of course, in district heating, and work is underway to consider appropriate forms of public sector involvement. Enabling legislation and the streamlining of the regulatory framework for district heating are being investigated.

6. Financing. This is the cruncher, of course, but should not be difficult to arrange if the energy savings are sizeable. District heating is a relatively low risk type of investment with the distinct prospect of generating net revenues. Especially if the economic comparisons use the appropriate replacement costs of energy, district heating using otherwise "wasted" heat is generally economically attractive to all the sectors I identified previously: users, operators, society.

The financing problem is likely to be most difficult with heat-only plants, and their associated distribution systems, that would be dependent on fossil fuels. For these, the immediate energy

conservation benefits are often small. But the other advantages remain: reliability of supply, user convenience, flexibility of fuel type, as well as new jobs for the Ontario economy.

The flexibility of fuel source is worth commenting on further. As indicated in this Ministry's report, Ontario's Energy Future, although our access to non-renewable energy may be adequate in the near term, we in Ontario must be investigating and investing in ways to bring about a transition to renewable sources, especially for low-grade energy requirements such as space heating. A central heat plant in a district heating system can use a wide range of compatible fuels, including active solar assist and refuse incineration. The key is a relatively low temperature hot water distribution system, and that's what we want to see in Ontario in the next few years. With a distribution system in place, the dependence of a community on any one type of energy source is reduced, and the options of energy conservation through use of renewable resources or of combined heat and power generation are preserved.

The package you received on registration this

morning includes two reports that show where we have been with respect to district heating. They, together with the Nuclear District Heating Study by Acres-Shawinigan in 1976, should provide those of you new to district heating with a background of work to date.

In February of this year, this Ministry, in co-operation with the Ministry of Industry and Tourism, sponsored a technology mission to Sweden, Denmark and Finland. Several engineering consultants, an architect, Ontario Hydro, Consumers' Gas Co., Modern Power and Engineering, and the Ministries of Energy, Housing, and Industry and Tourism all participated. The purpose of the trip was to consider the organization and operating experience of European district heating as lessons for Ontario. The large cities of Stockholm, Copenhagen and Helsinki were visited, as were cities of under 100,000 population, such as Västerås and Odense. Bringing to a wider audience the results of this trip is an appropriate point of focus for this seminar. I am pleased to introduce Bruce Richardson of H.H. Angus & Associates Ltd., who will speak on the transferability of European experience in district heating to Ontario.

"TRANSFER OF EUROPEAN EXPERIENCE
IN DISTRICT HEATING TO ONTARIO"

Bruce Richardson

H.H. Angus & Associates Limited

I would like to open by congratulating the Ministry of Energy for sponsoring the technology mission to Scandinavia. As an engineer who has been involved with district heating in Ontario for over 20 years, I welcomed the opportunity to meet with my counterparts in Scandinavia, to see the latest in their plants and equipment and to compare design methods and operating experience.

I found the trip to be well organized and conducted, the sites selected interesting and well-suited for our purpose, and our hosts more than willing to share their experience, both the good and the bad, with us.

I would particularly like to thank the co-leaders of the technology mission, Fred Molland, of Industry and Tourism, and Dr. Yang of the Ministry of Energy, for so ably leading and tending to the various problems that come up in a trip such as this -- congratulations on a job well done.

What specifically did we learn on the mission that could be applied to the study of district heat for North Pickering?

What are they doing in Europe that is different from the way district heating is done here? Why is district heat so successful in Europe, while at least in the past, it has not always been successful here?

In attempting to answer these questions, I will deal first with the technology aspects, and then I plan to mention some of the factors that are different in Ontario and that I think help to explain why district heating has been more successful in Europe than in Ontario.

WATER VS. STEAM

Turning first to the technology, the most obvious difference between European and North American practice is the use of water rather than steam as the heat carrying medium. Although there are a few older steam systems, the general rule for district heating systems in Europe is water, while in Canada and the U.S. the general rule has always been steam. Where water has been used in Canada, it has been high temperature -- 300 - 400° F. Water systems in Scandinavia are low temperature -- generally less than 250° F.

Why the difference in approach? Well, I believe that it's partly a matter of habit -- engineers who are familiar with steam tend to find reasons to justify it, while engineers who are familiar with water systems tend to find reasons to

justify water. But it is also a matter of precedent. Once you start with a steam system or a water system, it's very difficult to change.

There are, of course, long lists of the advantages and disadvantages of each and I won't take the time this morning to go into all of these, except to say that a major advantage of low temperature water over steam is a reduction in system line losses. This is the result of elimination of flashing at traps, reduced radiation losses due to a smaller temperature difference between the heat in the pipes and the surrounding atmosphere, and the fact that in a water system, the water is virtually always returned to the plant. In steam systems, on the other hand, the condensate is often dumped.

The disadvantages of water systems include difficulties in metering the heat consumed and in extracting sufficient heat from the lower temperature heat source to make the system viable. The Scandinavians have solved these problems for their purposes and so as the first item in the transfer of European experience, we will be basing the study of district heat for North Pickering on the use of a low temperature water distribution system.

METERING

I mentioned that one of the problems associated with hot water systems is that of metering the heat used. This is particularly true of the "standard" Scandinavian system, wherein not only the quantity of water circulated in the system is varied but, depending on the outdoor temperature and in some cases wind velocity, the temperature of the district heating water is changed. Typically, the supply temperature varies from a high of 120°C . at -20°C . ambient to a low of 75°C . at $+10^{\circ}\text{C}$. (Fig.1-p28). The return temperature varies with the utilization by the consumer and the district heat authority has no direct control over this. I'll come back to this later, however.

The heat supplied to the system is controlled by varying the supply temperature down from 120°C . to a minimum of about 75°C . and below this by reducing the volume of water circulated (Fig.2-p29). The scheme results in lower line losses during periods of light load while at the same time ensuring adequate minimum temperature for domestic hot water heating. The major disadvantage of the scheme is that it complicates the problem of metering. It becomes essential to use some form of heat meter -- that is, a meter which accurately measures not only water flow to the consumer, but also the temperature difference between the supply and return mains and then converts these two measurements into some form of heat unit such as BTU's or MWH or GJ.

The Swedes market a number of meters which do this with acceptable accuracy. The typical meter has an accuracy of ± 1 per cent at heat consumption rates within 50 to 100 per cent of the range of measurement; ± 2 per cent when operated within 25 to 50 per cent of the range and ± 4 per cent when within 10 to 25 per cent of the range. Obviously, it is important not to oversize the meter.

The meters are expensive, however. In Sweden, a heat meter of the size commonly used in single family homes costs the equivalent of about \$400.00 Canadian. So far, the nearest equivalent meter we have been able to locate here costs about \$800.00. Even in Sweden, where there is a highly competitive market for the meters, we were told that it is difficult to justify individual metering for single family homes, but that they are now being installed for "political" reasons. This is an important area that we will be investigating as part of the study.

HEAT EXCHANGERS

I mentioned that the Scandinavians have been able to successfully utilize the heat contained in relatively low temperature hot water sufficient to make such systems viable. In Figure 1, the graph shows a temperature difference between the supply and return mains on a design day of 55° C. or 99°

F. This difference is substantially higher than we would normally expect, and in order to achieve this, the Scandinavians use two, three, and even four stages of heat exchangers. Fig.3-p30 shows a four-stage installation. The hot incoming water is first used in an exchanger for high temperature applications such as a dryer or dishwasher. In the second stage exchanger, the water heats the final stage of domestic hot water. In the third stage, radiator water is heated, and then in the fourth stage, the domestic hot water is preheated. In this way, the maximum heat exchange takes place between the district heating water and the consumer's system.

Application of the multi-stage heat exchanger principle in Ontario will require some modifications, but the basic principle is sound. In the first place, the Ontario Plumbing Code prohibits the use of chemically treated water at a pressure higher than city water to heat domestic water. District heating water must be chemically treated to prevent corrosion of the pipes. The concern is, rightly, I believe, about the possibility of contamination of the domestic water supply. This problem will also be investigated and resolved as part of the study.

In the second place, the standard method of heating in Ontario is by forced air rather than hot water, but this

simply means a water-to-air heat exchanger rather than water to water. It is quite likely that in Ontario the multi-stage principle will have to be supplemented with a control valve and by-pass arrangement to ensure maximum temperature drop in the subscriber station before the water is allowed to return to the system.

PIPE PROTECTION AND INSULATION

A major problem with older district heating systems both in North America and in Europe has been corrosion of the pipes and high distribution system line losses due to breakdown of the insulating system. Many of these systems were installed at a time of low fuel cost and when the major concern was low capital cost. We are not alone in experiencing these problems and during the mission, we heard stories of real disasters in district heating systems due to bad design and selection of distribution system materials.

The ultimate in system protection is the vast tunnel system in Stockholm, but tunnel systems are generally too costly to justify except in very special circumstances. Although a poured-in-place cork bitumin system is currently popular in Denmark, the standard for distribution mains in Scandinavia is still steel pipes and a precast concrete enclosure.

For smaller secondary lines to individual subscribers, prefabricated conduit systems, using insulated copper tubing covered with polyethylene, are popular. The flexible piping can be laid without anchors and expansion joints, and the cost of installation is substantially less than conventional systems. We will be investigating the use of this and other lower cost distribution systems for North Pickering.

At Studsvik, the Swedish equivalent of Chalk River, we saw some of the extensive testing being carried out on plastic piping. Although plastic pipes seem to hold promise for lower cost distribution systems in the future, the practical temperature limit at the present is 90° C., and the general consensus among Scandinavian consultants and users we talked to was that, so far, the use of plastic pipes for distribution is unproved technology.

SCANDINAVIAN EXPERIENCE

Obviously, in two weeks of touring installations in company with 10 other engineers, you can at best only pick up some general impressions. But I did see enough to convince me that we can benefit from the Scandinavians' experience. To ensure that we have the benefit of that experience, we have retained the Swedish consulting firm of Theorell & Martin as

a sub-consultant to us in the Pickering study. Mr. Erik Wahlman, President of Theorell & Martin, has already been to Canada in connection with his participation, and will be working closely with us throughout the study.

I have concentrated on the technology aspects in the transfer of experience but, of course, the financial, organization, ownership, tariff structure, and general operating methods of successful European district heating systems are also available to us, and we will be investigating these through our associates to see how they can be adapted to our use in Ontario.

DIFFERENCES

While weather, the general level of development, and many other conditions in Ontario are similar to those in Scandinavia, there are some differences which have a bearing on why district heating is more successful in Scandinavia than it has been in Ontario.

FUEL

One of those differences is the alternatives available

to a potential consumer of district heat. With the exception of peat in Finland, there are no native fuels in Scandinavia. They must import virtually all of their fuel and at world market prices. Natural gas is simply not available for home heating. In Canada, we have natural gas and oil which are still marketed at less than world market prices.

In Ontario, the competition for district heat for an individual consumer is normally a gas-fired furnace. In Scandinavia, the competition is either electric heat or an oil-fired hot water boiler. Whether the district heating system can compete in Ontario will come out in the study, but a gas-fired furnace costs less and operates cleaner than an oil-fired boiler and it obviously costs less to run a single gas pipe to a consumer than it does to run two insulated hot water pipes. These factors tend to make district heating more competitive in Scandinavia than in Ontario, but they will become less significant as Canadian fuel prices escalate to world market prices.

BUILDING DENSITY

Another difference in practice favouring district heat in Scandinavia as opposed to Canada is the density of building development. Single family homes tend to constitute a

smaller percentage of total housing in Scandinavia, and where they are built, are relatively small houses densely located by Canadian standards.

We are still working on load calculations for North Pickering, but obviously district heat is most viable in more densely populated areas. Due partially to the high cost of land and construction, but also to the change toward smaller families, Canadian standards are changing and in new developments we see more apartments, row and town housing and fewer single family homes. These changes will help to make district heat viable in Ontario.

COMPARISON OF ENERGY CONSUMPTION

During the technology mission, we had the privilege of visiting the home of an individual subscriber who had recently been converted from his own oil-fired boiler to district heat. Some of you may have heard Mr. Grels Berg present a paper at one of the district heating seminars put on last year by the Swedish Export Council. Mr. Berg is a prominent engineer involved in district heat and kept careful records of the energy consumed by his oil-fired boiler system and the heat energy that he purchased from the district heating authority. According to Mr. Berg, his energy consumption was exactly one half with district heat as opposed to what it had been with his own boiler system.

In a recent survey, the Tenants' Association in Sweden found that district heat costs, on the average, about 10 per cent less than other methods of heating. As our energy costs escalate, as our housing densities increase, well-designed and operated district heating systems in Ontario could well offer the same sort of cost advantage to the Ontario consumer.

There are differences and there are some problems in adopting the European experience, but I see a very real potential for district heat in Ontario, particularly where it can ultimately be combined with garbage burning, co-generation of power or other utilization of waste heat. The engineering study of district heat for North Pickering is an important step in determining whether the European experience is applicable to Ontario and whether district heat, with its attendant benefits of energy conservation, reduced air pollution, and increased reliability and convenience for the consumer, is viable in Ontario.

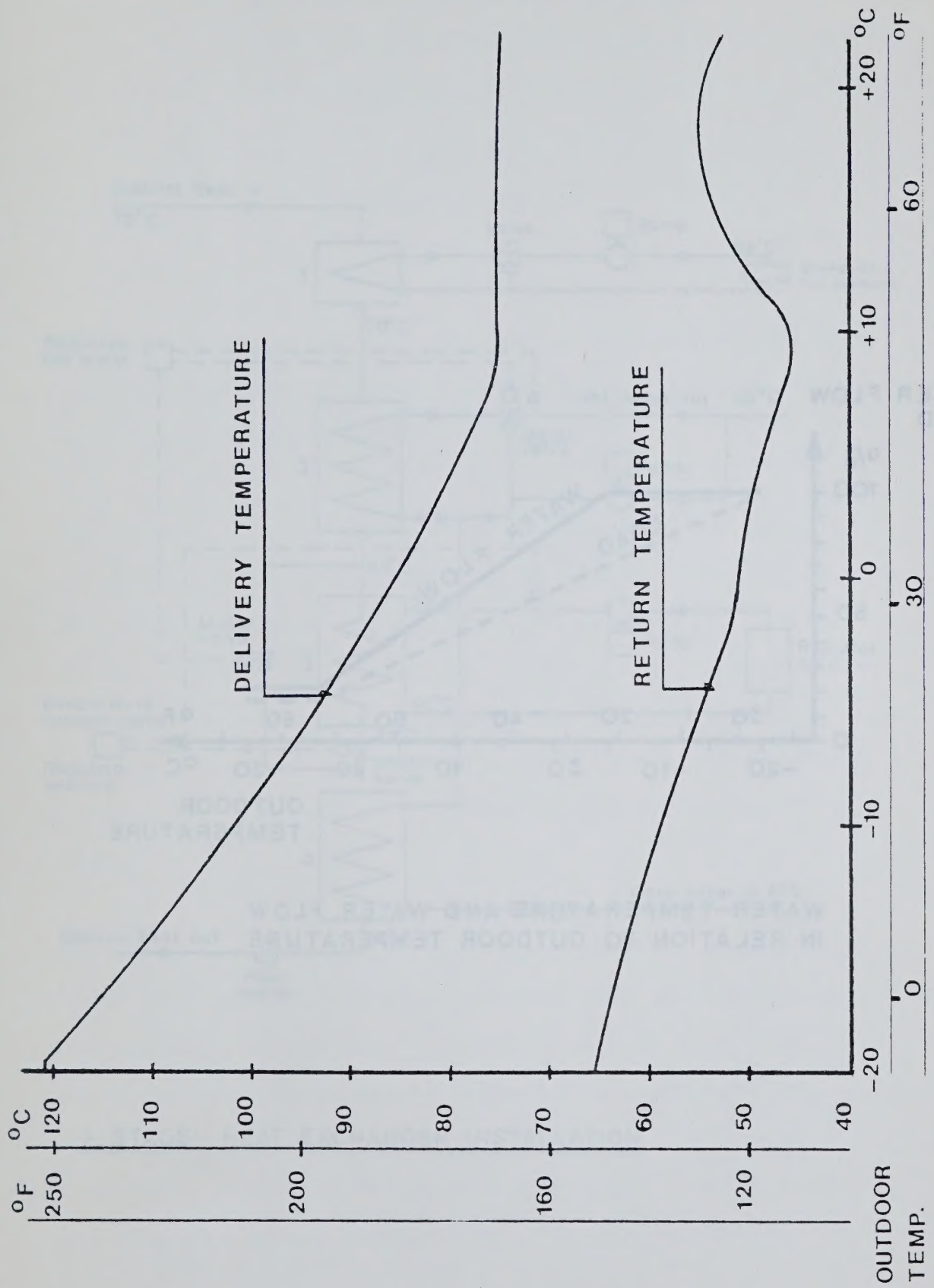
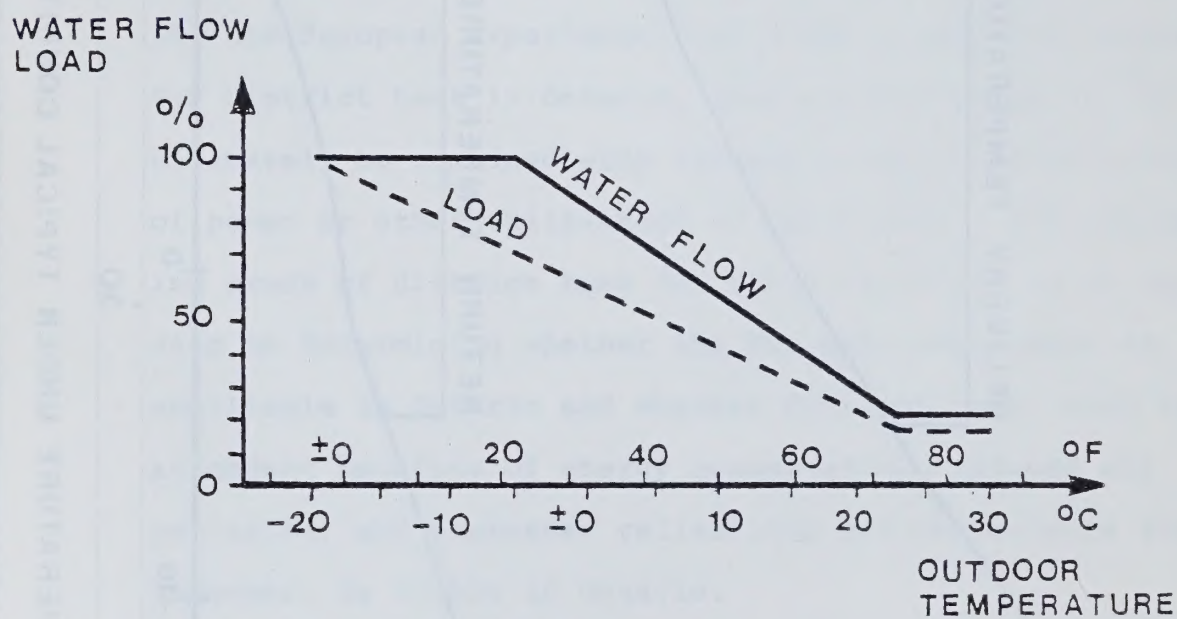
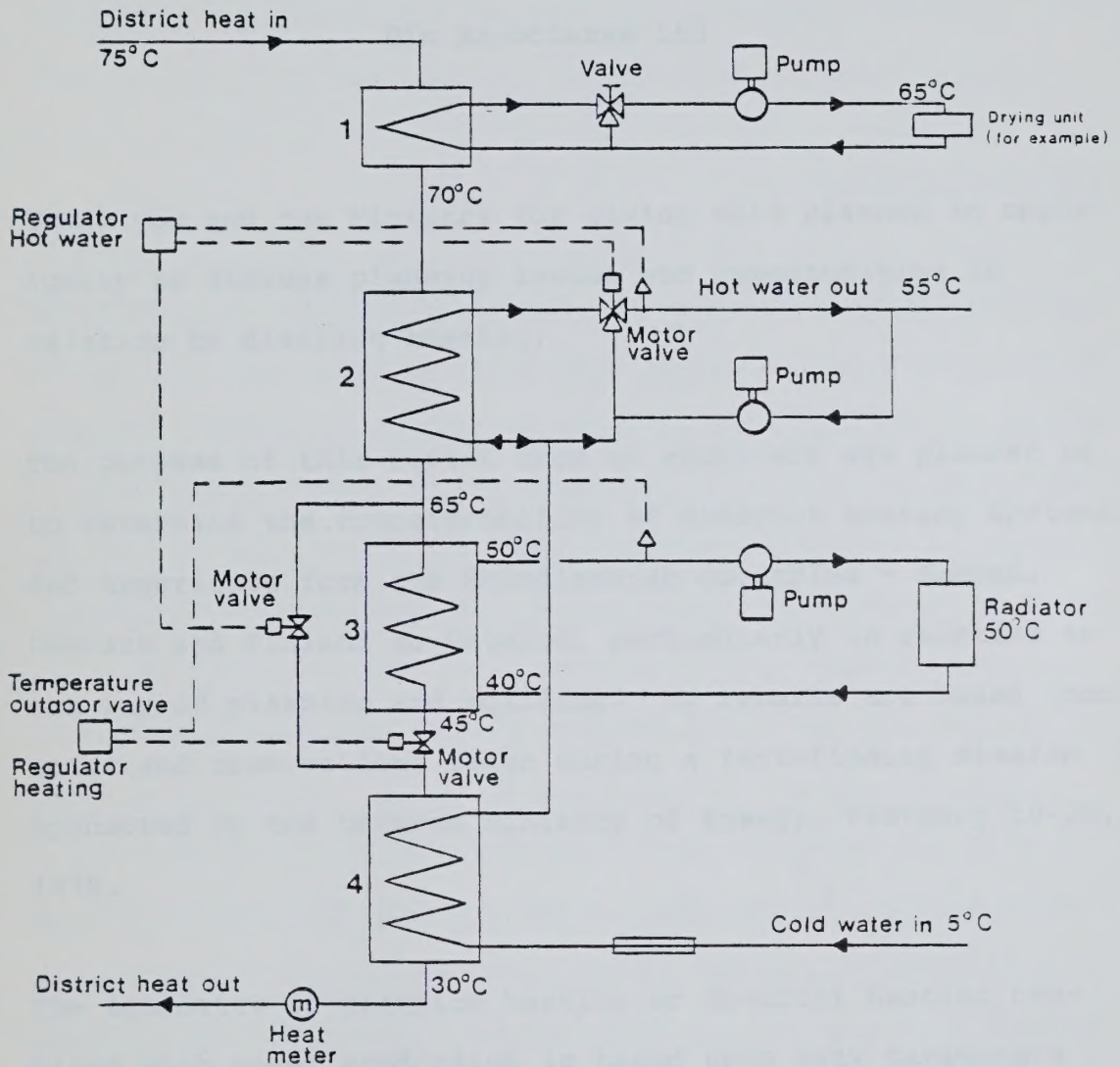


Fig.1

WATER TEMPERATURE UNDER TYPICAL CONDITIONS



WATER TEMPERATURE AND WATER FLOW
IN RELATION TO OUTDOOR TEMPERATURE



4 STAGE HEAT EXCHANGER INSTALLATION

"THE TRANSFERABILITY OF SCANDINAVIAN
CENTRAL DISTRICT HEATING SYSTEMS
AND BUILDING CHARACTERISTICS TO
THE ONTARIO CONDITION"

John Hix

Hix Associates Ltd.

Thank you and the Ministry for giving this planner an opportunity to discuss planning issues and opportunities in relation to district heating.

The purpose of this report from an architect and planner is to determine the transferability of district heating systems and experience from the Scandinavian countries - Sweden, Denmark and Finland to Ontario, particularly in relation to our way of planning and building. My remarks are based upon notes and observations taken during a fact-finding mission sponsored by the Ontario Ministry of Energy, February 10-25, 1978.

The economics of district heating or district heating combined with power production is based upon many parameters and specific to the energy circumstances of each country. It is my intention today to point out the similarities and dissimilarities when comparing Scandinavia and the Ontario condition. These relate to the energy use, land ownership, and domestic energy capabilities. I will attempt to em-

phasize discussion of the built-form as it relates to district heating, thermal demand load, orientation, heat density, and the integration of district heating equipment into the townscape.

DISTRICT HEATING

District heating is simply a heating distribution system for many buildings on a large community or town size scale. The source of heat is usually a boiler plant (permanent or temporary) or back pressure heat from a power generation station, a so-called combined heat and power plant. Major capital investments are required for the plant, the insulated transmission and distribution pipes, and the heat exchangers and metering devices in the individual buildings.

The main argument for promoting the use of large heat producing plants is that their efficiency in converting fuel to heat is some 20 percent higher than individual private furnace installations. Also, these plants can burn dirtier, cheaper fuels (such as black or brown coal, heavy oil, wood or peat) and still maintain acceptable clean-air standards. The large plant, usually remote from the housing area, affords the opportunity for burning many alternative fuels, particularly solid fuels, thus providing more security of supply. Heating plants represent major capital investment and the trend in Scandinavia today is to encourage the

conversion of heating plants to the combined power and heat production. Fortunately, Scandinavia has little summer air conditioning and a great deal of natural evening light, and therefore the summer and winter demand curves for electricity and heat are roughly parallel or at least supportive.

A plant is usually uneconomic unless it has sufficient connection to large heat demand sectors such as dense areas of cities. The distribution pipe and plant sizing (and therefore capital cost) is related to the peak hour load while the fuel costs and annual revenues are determined by the annual load. Therefore load factors become increasingly important in the determining economics.

HEAT LOAD DENSITY, BUILDING DENSITY, THE PIPING SYSTEM

Heat load density also relates directly to the ratio of floor area of building to land area the so-called (floor/plot ratio). The cost of the distribution piping and metering and heat exchange equipment is determined by this density. For example, higher concentrations of apartment buildings require short runs of larger pipes and fewer meters and heat exchangers. Low building density (townhouse or detached house areas) require long networks of small pipes, many individual meters and exchangers, and a higher heat loss in the distribution piping. (This loss usually

ranges from 5 percent to 10 percent depending on these circumstances.) The capital investment in the piping system, however, falls sharply as the amount of heat to be transmitted increases.

A recent Finnish paper* on district heating explained that a two foot diameter pipe can transport six times more heat than a one foot diameter pipe and costs only $1\frac{1}{2}$ times more. This basic cubed/squared law could have an influence on future urban form should it be district heated. This is discussed more fully in our recent report for the Porter Commission called Land Use and Energy.

Individual heat meters are not provided for each apartment in an apartment building because of costs. However, they are encouraged (sometimes by law) to be installed with new individual houses, thus encouraging conservation but adding cost to the district heating system. District heating representatives in Scandinavia were disgruntled by this new law because individual metering adds costs and encourages the reduction in the heat load.

District heating companies sell heat. Two charts from the Finnish paper are representative of many others collected during the mission. The first (Chart A) compares the distribution capital cost with the heat load density and the

* Unto Kilpinen, District Heating in Finland, 2nd National Conference on District Heating, Scarborough, England, 1977.

building density which is expressed as the amount of plot covered. It shows that capital investment per unit in piping rises sharply as the building density drops. The second (Chart B) deals with transmission pipes outside the distribution area; it shows that the capital cost per heat capacity falls as the amount of heat to be transported increases. In other words, extensive networks of small pipes are to be discouraged.

Thus it is obvious that district heating is more easily applied to central urban districts and/or concentrations of large apartment buildings. An historic and chronological look at district heating development in Scandinavia reflects this heat density factor. Stockholm, Västerås, Odense, Helsinki, Tampere, all began their district heating distribution in the centre urban cores. Lidingö, Sweden, a suburb, started its system with areas of high density clustered apartments. During the 1960's the demographic demand in Scandinavia for large numbers of housing units was fulfilled with large scaled concentrations of high density apartments in the new suburbs. These were connected to temporary heat plants and later, as the central piping systems grew towards the suburbs, connected to the central power/heat plant and other permanent heat plants. Not until recently have the heat loads become sufficiently large and the systems extensive enough to begin to hook up individual houses (except at Odense, Denmark and Västerås and Enköping, Sweden). For example, only 2 percent of the Helsinki power

company's district heating customers were detached or townhouses in 1975. Hervanta , a new town in Tampere, had 3,500 apartments and only 30 houses on district heating.

Reviewing the notes taken during the mission, some figures appear to emerge as viable heat load densities. The term viable is, of course, relative to the specific land use, energy source, construction costs circumstances.

Stockholms Energiverk	10 Mw/km ²	range 10-70 Mw/km ²
-----------------------	-----------------------	--------------------------------

Västerås Plant	8 Mw/km ²	
----------------	----------------------	--

Høslund Rasmussen, Consultant	15 Gcal/km ²	
Copenhagen		

Bruun & Sorensen,	10 Gcal/km ²	
Consultants & Contractors		
Copenhagen		

These figures are usually related to a mature and extensive district heating system.

The solution to the hook-up of small houses is one of scale. If, as in Västerås*, or Odense, the systems become large and extensive then the detached dwelling's cost of joining and using the district heating system can be competitive with

* 10 percent loss in distribution system mainly due to single family dwellings.

oil or electric heat. For example, in Västerås, Sweden, some 13,000 private ownership dwellings are on the system (these are not all detached houses). In Västerås, heat meters were not originally provided, thus lowering initial costs, but since 1975 they must be provided by law. In Odense, 800 km of pipes connect 28,000 private homes and 45,000 apartments to the system. However, it should be noted here that Odense runs an older and lower temperature system and that no heat exchanger or heat flow metering is used, thus saving dramatically on joining costs for single family houses.

THE EQUIPMENT IN THE ENVIRONMENT

Questions inevitably arise from Ontario municipalities concerning the characteristics of the district heating plants and associated equipment as it relates to the environment. There are four types of heat plants: large heat and power plants, large heat plants, large heat peaking plants and temporary portable boilers. The large plants are usually placed near bodies of water (a lake, sea) to facilitate fuel shipping and for cooling purposes. The buildings and the stacks can be formidable, but are not unusual to Canadian townscapes. The large peaking plants are also not objectionable in the immediate environment of housing. A permanent new peaking plant visited in Helsinki was posi-

tioned in the centre of a cloverleaf intersection. The vertical boilers and boiler room were mainly underground; oil tanks were surrounded by concrete walls architecturally treated; only the stack was a dominant feature, a focal point in the landscape. The heating plant at Albertslund, which was also burning dry refuse, could be considered a handsome, human-scaled building. There was no waste or filth around the building. It was, in fact, positioned next to a senior citizens' home. The trucks brought dry refuse packed in paper bags collected from each home. The whole operation was amazingly clean because a vacuum from the stack is created in the building allowing no smoke pollution out to the immediate environment.

The prefabricated transportable heat plants are positioned next to or within housing areas. They generally consist of a well-detailed metal enclosure containing a hot water boiler with oil tanks either within the enclosure or separate. The insulated metal stacks are from 45 to 90 ft. high and guy cabled to the ground. Positioned in the landscape amongst trees, this small plant is handsome and not obtrusive. These unmanned portable boilers are usually fitted with fault alarms transmitted by telephone for maintenance. Oil must be delivered to the plants. This is less objectionable than individual home delivery.

The heat exchangers in the homes or buildings are exceptionally clean as no combustion is taking place. The units are

considerably smaller than a furnace and water heater combined. The advantages, of course, are many; little noise (gas, explosion proof) little danger of fire, no chimney required, no oil leaks or smells, no oil delivery trucks, little maintenance, small mechanical rooms. Well-sealed houses of the future would not have the problem of providing outside combustion air.

In a sense, energy conservation measures in buildings can predicate against the positive economics of district heating, which depends upon selling heat. The energy conservation campaign begun in Finland in 1973 led to a clear drop in district heat sales in 1974 and 1975; sales were 10 percent below the precrisis level, even though new consumers are being added. The number of hook-ups has not decreased but the average size of consumer in Helsinki has decreased because the large buildings were connected in the first stage, and the system is now spreading out into the suburbs where there are lower densities of smaller buildings.

This trend toward conservation was pointed out at the Västerås, Sweden, power plant meeting where the housing heat demand had been calculated at 230 kwh/yr./m^2 before the energy conservation measures and now it is 150 kwh/yr./m^2 , a 34 percent reduction. This figure is within the same range of $150\text{--}200 \text{ kwh/yr./m}^2$ used at Lidingö, Sweden, for pipe sizing.

PLANNING AND BUILDING ORIENTATION

The mission confirmed that there has been little coordination in Scandinavia between city planners, architects, district heating system followed a plan which was based upon parameters other than energy efficiency or economic pipe layouts. There was little recognition of sun orientation except at Albertslund where the single storey court houses were oriented south. There would seem to exist large scope in the future for economic improvement with the integration of appropriate planning patterns that shorten pipe lengths.

The rational layout of buildings along simple systems and the discouragement of fine networks and the added coordination of town planning and heating system design was considered desirable for the future and mentioned at Lidingsö, Vasteras, Sodertorn and Studvik. At Västerås, Gunnar Asker, the municipal town planner, said that with the higher insulation standards, the Swedes are beginning to understand the positive qualities of passive solar gain and that new legislation will be enacted to encourage windows on the south of buildings. He emphasized that the district heating systems in Sweden should be at a lower temperature so that advantage could be taken of other energy sources such as solar and heat pump technology.

INCENTIVES

Perhaps now I could say something about incentives for the adoption of district heating.

European experience demonstrates that central district heating can ultimately provide cheaper heat to the consumer. In Västerås, for example, electric heat costs three times that from the district heating system. This, of course, is the major economic incentive. In apartment buildings, the total district heating cost is approximately 10 percent below that of oil or gas. For houses, the tariff is structured so that the cost is equal to the oil alternative. The worry-free advantages of district heat, therefore, create the waiting lists for joining the system. The initial hook-up is always difficult. Gunnar Asker, planner, mentioned that in Västerås most of the land was owned by the municipality (land bank) and that at the beginning any new construction was "forced" to hook up with district heat. The amount of land owned by the municipality makes Västerås unique in Sweden.

Presently, a law does exist in Sweden which allows a district heating company to seek certification as a "public" system, which means that it can legally collect a hook-up fee. The law has not been applied anywhere in Sweden

because no municipal district heating company has sought such certification, because of fear that it might cause demands from a consumer for district heating in circumstances which clearly are not economic, and they would have to hook him up.

An important incentive in Scandinavia is that mortgage interest on housing can be deducted from income. Many Scandinavians therefore carry large mortgages for this reason. The National Housing Loan (CMHC type) allots to electric heat a maximum of 3,000 Sw Kr* and for a district heat exchanger 17,000 Sw Kr. The fact that heat from a district system costs about 1/3 that of electric heat creates a positive incentive for the selection of district heating by the owner. There also exists a much higher tax on electricity in Sweden. Since 1971, the taxes on electricity quadrupled, while only doubling for oil. This discourages the use of electricity for heating even though capital cost is lower. Scandinavian district heat utility companies always try to balance tariffs between high demand users and low demand users in order that district heating can be competitive with other alternative forms of heating in the open market. It is clear that economic incentives from government have been necessary.

SIMILARITIES, DISSIMILARITIES

Scandinavia has a history of municipal land banking and

* One Sw Kr = 25 cents Cdn as of February 1978

schemes for leasing land instead of free sale (particularly in Sweden). This provides a leverage that does not exist in Ontario and one that helps promote any collective activity like district heating. The city urban cores of Copenhagen, Helsinki, and Stockholm are compact five to seven storey buildings forming high density city blocks and high concentrated heat loads. During the 1960's and early 70's, as mentioned before, large scale housing developments at high densities were built forming large heat load clusters in suburban areas. Thus, this model of urbanism is carried into the suburbs where even higher density of collective forms appear to be more acceptable (for example, the new town of Hervanta, a suburb of Tampere). Whereas Scandinavia has a heritage of land banking and urbanism, we have fostered low density site development and have formed a suburban mentality since the early 1950's. However, we do have concentrations of high density in suburbia, to the amazement of our cousins to the south.

With little or no domestic fuel sources, Finland, Sweden, and Denmark are net importers of energy*. Being placed in this vulnerable position provides the circumstances for steering large capital investment to district heating. Ontario also has little fossil fuel, but has deposits of uranium. This places Ontario, as a province which imports more than 80 percent of its energy requirements from the rest of Canada and other countries, and which is heavily

* Denmark imports 98 percent of its primary energy; however, Sweden has 60 percent of electric needs from hydro power.

dependent on oil, in a similar position to the Scandinavian countries.

Forced warm air heating has not been popular in Europe, and few systems exist in Scandinavia. Hydronic heating with wall radiators is the universally accepted form. This is adaptable to district heating; particularly for a system like Odense, Denmark, where the hot water is piped directly into the houses without a heat exchanger. The environments in Scandinavia have little or no humidification. On the other hand, we are used to hot air heating and winter humidification. It is important for us to ascertain whether our heating systems can be easily converted to district heating with the installation of heat exchangers in the bonnet of the furnace or new water to air fan-coil units. On the other hand, many of our apartment buildings constructed during the past twenty years and in downtown areas have hydronic systems and a potential for district heating connection because they also provide the appropriate heat load density.

THE NEED FOR ECONOMIC STUDIES ON HEAT LOAD AND DISTRIBUTION SYSTEMS

The last day of the mission was spent with Ekono, an energy engineering company in Tapiola, Finland. They demonstrated,

with several studies, that district heat is competitive in dense centre core areas and in dense suburban areas; that natural gas is often the chosen alternative for less dense suburban areas, and that electric heat is an alternative in outlying communities away from oil and gas sources. (Basel, Switzerland Study, Ekono).

They surmised that district heating was too expensive in low density areas unless these were next to or along the pipe lines to higher density heat loads*.

Several Scandinavian consultants indicated that the distribution temperatures (120 degrees C.) in Scandinavia were too high and that in the future low temperature systems using non-corrosive piping (cross linked polyethylene) and cheap plastic radiators could provide solutions. The reduction or elimination of heat exchangers and expensive metering could lower capital expenditures. The economic viability of district heating for low densities could well be highly dependent on this new technology. Transmission temperatures could remain high, and carry energy long distances from nuclear power plants to local district heat exchangers for distribution.

* The National Housing Board, Helsinki, used the figure of .3 land coverage for two storey buildings as being viable for district heat. We interpret this to be town housing at 10 to 15 units per acre.

It is necessary to point out that the decision whether to use district heating or not, while primarily economic, is also tied to other considerations such as pollution control and long term planning and survival instincts and adaptability to various fuels -- oil, coal, peat, refuse, gas, wood, etc. Here in Ontario our alternative to the expense of district heat systems would seem to be the spending of capital to upgrade our buildings thermally and the distribution of natural gas, which at present is in abundant supply. But this is not a long term view. While the thermal upgrading of our existing building stock (to lower demand) is unquestionably our first priority, the use of natural gas could be considered only a short-term alternative because Ontario has no natural gas supplies. The fuel source flexibility associated with district heating, the opportunity for transition to renewable sources if low temperatures can be maintained, and the use of so-called waste low temperature heat from power generation, support a longer term view. We cannot disregard the fact that our only indigenous traditional fuel is uranium and that presently we are dumping large quantities of valuable heat into Lakes Ontario, Erie, and Huron. This is an unnecessary waste and the mission to Scandinavia heightened my awareness of this waste. The circumstances of power plants related to North Pickering and Townsend could offer interesting opportunities if the economic heat loads are met or new geometric building patterns are planned.

The energy circumstances related to each country, to each community, are varied. A careful study on the optimization of systems, size efficiencies of plants, the piping system, water temperature, heat density, air quality and multi-fuel flexibility, compared with competitive alternatives, must be carried out before any categoric statement can be made as to the application of central district heating in the Ontario condition.

There is a tendency in Ontario today toward more collective medium density housing for reasons other than energy savings. This would support district heating. Though there is presently a clear difference between our general building densities and that of Scandinavian cities, our rejection of suburbanism could provide the circumstances for many collective advantages such as district heating and low energy requirements of compact forms of buildings; the advantages in fuel savings and pollution control merit a hard economic look.

In Scandinavia, patterns of housing have been laid out on the ground in conventional historic patterns, with little regard to energy and land conservation orientation and slight concern for the optimization of the district heating system that serve these buildings. Here in Ontario, we are considering the idea of implementing district heating for

North Pickering. This development and that of Townsend provide greenfield circumstances that would afford the opportunity for the early integrated efforts of district heating engineers, planners, and architects in the preliminary design stage of the development. The building forms and the geometric patterns of buildings on the ground should be for the first time a factor in the optimization procedure which previously only applied to the mechanical distribution systems and heating plants. We must also take a hard look at the older, more dense parts of our cities, and particularly redevelopment schemes to ascertain the district heating viability through integrated design.

Rationalized housing patterns could reduce district heating distribution piping to the minimum. Well-insulated housing units could reduce the required water temperature allowing for the implementation of low cost materials and techniques in the distribution systems, unit radiators, and heat exchangers.

These building patterns that reduce district heating distribution costs will also reduce conventional servicing, water, sewer, and electrical costs. Therefore, the total economic impact of these patterns could be very positive indeed. This optimization that includes rational geometric land use patterns could therefore provide for affordable housing; affordable in capital cost and energy use, important concerns for the citizens of the Province of Ontario who

must contend with a cold and dark winter climate and increasing costs of energy into the future. Though the economics of district heating, like that of solar energy, do not appear to be exceptional at this particular time, the Scandinavians have proved that their efforts reap rewards. Pilot demonstration projects in district heating specifically tailored to the Ontario condition would be well worth supporting by those who share a long-term view for our Province. Thank you.

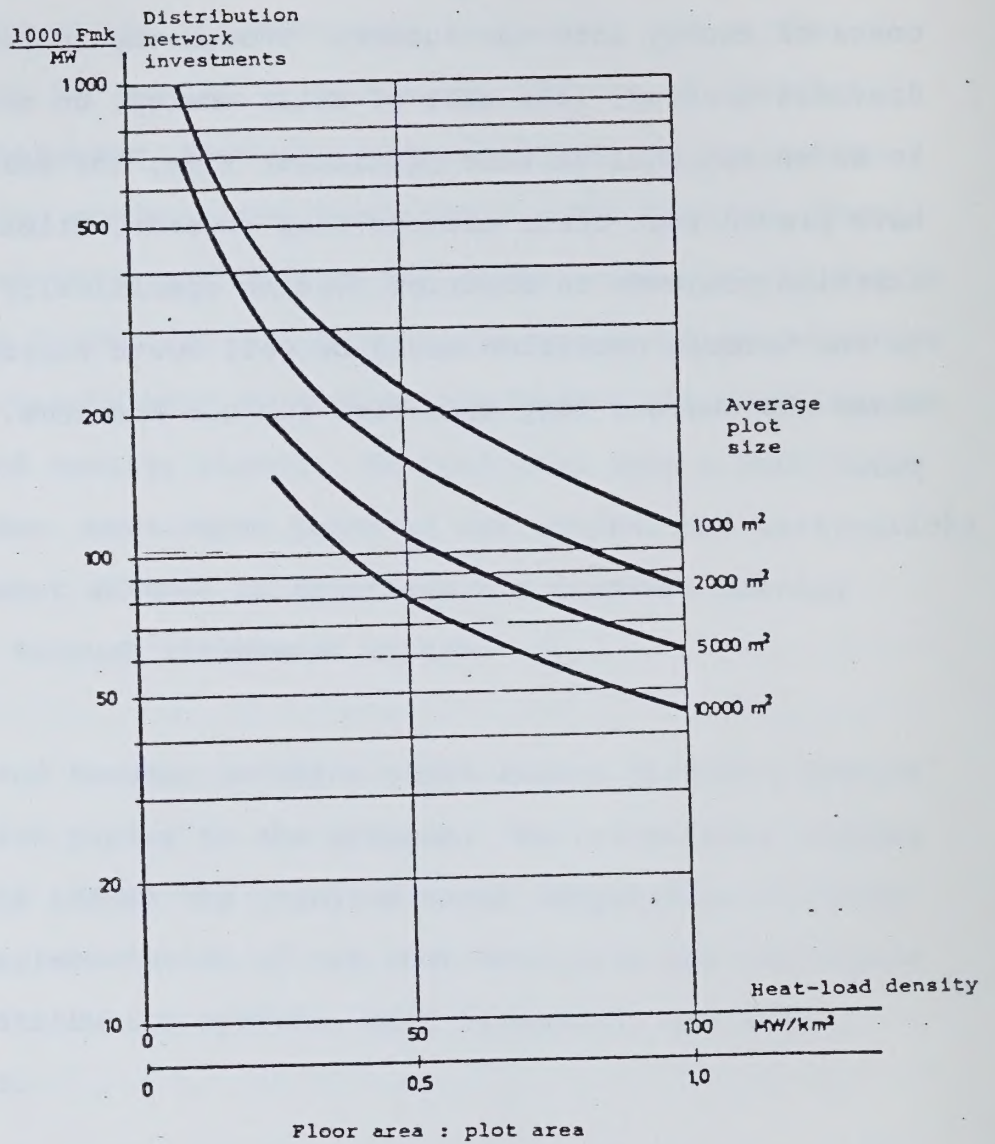


CHART A *

(from Unto Kilpinen's paper
District Heating in Finland
Scarborough, England)

* Note: This chart does not support the statements₂ from Stockholm's Energiverk where 10 Mw/km² was considered to be marginally cost effective.

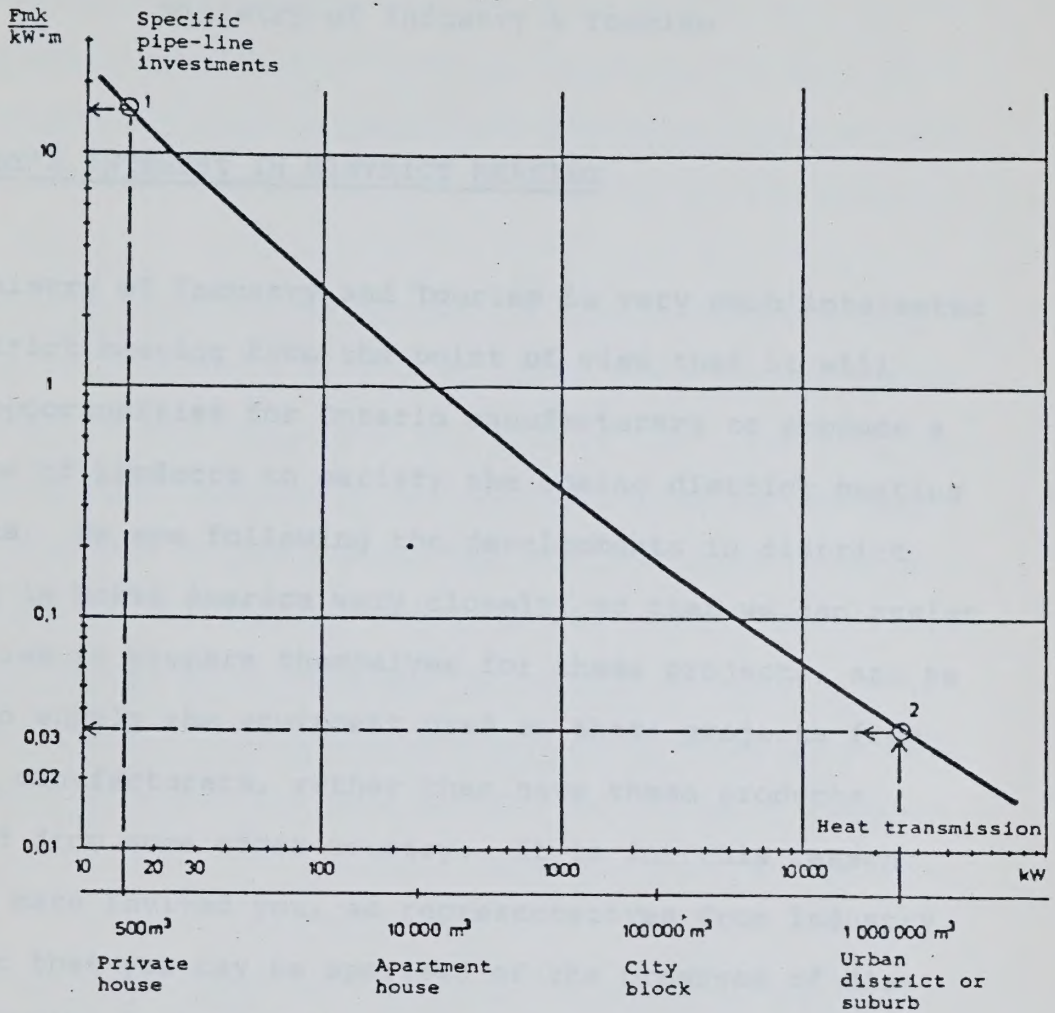


CHART B

It should be noted that Charts (A), (B) are qualitative indicators only - real costs are highly dependent on site - specific conditions.

"OPPORTUNITIES IN DISTRICT HEATING FOR ONTARIO MANUFACTURERS"

F.W. Molland,

Ministry of Industry & Tourism

MINISTRY'S INTEREST IN DISTRICT HEATING

The Ministry of Industry and Tourism is very much interested in district heating from the point of view that it will offer opportunities for Ontario manufacturers to produce a new line of products to satisfy the coming district heating projects. We are following the developments in district heating in North America very closely, so that we can assist industries to prepare themselves for these projects, and be ready to supply the equipment used on these projects from Ontario manufacturers, rather than have these products imported from some other country. It is for this reason that we have invited you, as representatives from industry, in order that you may be apprised of the progress of district heating in Canada.

DISTRICT HEATING A REALITY IN EUROPE

We believe that district heating will become a reality in many communities here in Canada, just as it has become a reality in most communities in Europe. In Europe, and many other parts of the world, the energy crisis has existed for

some time and they have had to adopt methods of conserving energy long before we became aware of an energy crisis here. Thus, they are more than a decade ahead of us in planning and implementing energy conserving programmes, of which district heating plays a major part.

METHOD TO USE WASTE HEAT

District heating will solve other problems for industry in energy conservation, in that it can act as a heat sink to absorb waste heat from industrial processes, or municipal waste or power generating stations, and thus provide a method of improving the efficiency and profit of such an industry by providing revenue from its waste heat, which otherwise would be a total loss.

DISTRICT HEATING COMPONENTS

The products that we see as offering opportunities to be developed and manufactured by Ontario manufacturers are as follows:

HEAT EXCHANGERS used in homes, apartments, commercial and industrial buildings that exchange the energy from the district heating system to the system of the customer, both

for domestic hot water and the heating system of the building. Since many Canadian homes are hot air heated, a special water-to-air heat exchanger with fan, filters, humidifiers, etc., to replace the oil or gas furnace, will have to be produced.

METERING EQUIPMENT for measuring the energy in BTU's delivered to each customer will be needed. This is an integrating meter which measures the flow of hot water from the district heating system and the incoming and exiting water temperature and integrates the results in energy supplied.

PUMPS, CONTROL VALVES, TEMPERATURE INDICATING AND CONTROLLING DEVICES, INSULATING, PIPING, RADIATORS, AND ASSOCIATED HARDWARE will make up part of the package required.

PRECAST CONCRETE DUCTS for enclosing, supporting and protecting the distribution of district heating piping will also be required. The piping and insulation for this system will be a big requirement. On branch circuits and feeders to individual customers, preinsulated copper pipe and fittings make a sizeable manufacturing opportunity for Ontario industry.

PORTABLE PACKAGE BOILERS provide another item of requirement that can be manufactured by Ontario industry. In

conjunction with this, the ancillary equipment such as oil tanks, stacks, and all the usual hardware associated with boiler plants, plus the remote control equipment, wiring and control consoles will be required.

MINISTRY'S MISSION FOR MANUFACTURERS

The Ministry of Industry and Tourism is planning on preparing a mission of Ontario manufacturers to Europe, who are interested in preparing themselves to manufacture these district heating components and want to see how it is done in Europe. They will also have the opportunity of visiting European manufacturers of such equipment and arranging for technical or licensing agreements with such manufacturers.

The timing of this mission has not yet been set, since, to our knowledge, no district heating project has yet been approved -- although there are some in the planning stages. However, prearrangements will be made so that the mission can be organized on short notice. The time lapse between the approval of a district heating project and the ordering of any components, we understand, will not be less than two years. It will take this time to detail the design and make all the preliminary arrangements. We believe this will be sufficient lead time for manufacturers to set up to man-

ufacture such components. We are tentatively expecting this mission to be about a year from now.

Companies wishing to participate as mission members should write to their local field office of the Ministry of Industry and Tourism or directly to the Energy Conservation Group of the Ministry of Industry and Tourism at Queen's Park, requesting to be included on this mission. The membership of such missions is usually limited to about 12 persons. The Ministry makes all the arrangements, reservations and programmes and pays the major transportation costs. Individual members will bear the other costs such as hotels, meals, taxis, etc.

MINISTRY'S STUDIES ON DISTRICT HEATING

A study on district heating as it relates to business opportunities for manufacturers, has been prepared by the Ministry. The study sums up the current status of district heating in Canada. It lists and describes the various components used in district heating systems and the names and addresses of the manufacturers of these components in Europe, the U.S.A. and Canada. It is a very complete directory on such equipment and the only one I know of in existence. It comprises over 400 pages of information, literature and pictures. It is available at the government bookstore for approximately \$7.50, which is the cost of the printing. Anyone wishing to obtain a copy can purchase it at the door or from the Government of Ontario Bookstore, 880

Bay Street, Toronto. The Ministry has also prepared a study on solar collectors and how this industry offers opportunities for Ontario manufacturers; this is also available at the government bookstore for \$1.50. A study on insulation material and related building products is in the final stages of preparation. It gives a market survey of products manufactured in Canada and describes materials which offer opportunities for Ontario manufacture that are produced in Europe and the U.S.A., listing the companies that own the patents and know-how. One well-known product produced in many countries known as Siporex has no license in North America and offers a manufacturing opportunity for an Ontario manufacturer. This study will be available at the government bookstore by August.

A study on heat exchangers and recuperators is also being prepared and will be available by August.

The intent behind all these studies is to make available enough information on energy-related products that we feel offer opportunities for Ontario manufacturers to produce.

The Ministry is also contemplating sponsoring the publication of a directory of products relating to energy conservation and their manufacturers, so that anyone interested in finding energy-saving products will have a quick reference to locate such product information.

Other programmes in the energy field are the continuance of the energy bus programme and the plant energy evaluation programme, which is a government subsidized, professional energy survey of industrial plants. There is also the Energy Award Programme, which offers an award for the best energy conserving idea in industrial plants. Other energy-related programmes of the Ministry of Industry and Tourism are as follows:

SEMINARS

Energy Evaluation Seminar	September
Insulation Materials Seminar	October
District Heating Components and Heat Exchangers Seminar	December
Solar Technology Seminar	December

MISSIONS

Solar Equipment - Italy	October
A.S.H.R.A.E. Convention	January

STUDIES

Heat Pumps
Retrofitting Industrial Building for
Energy Conservation

Training Programs for Energy Conservation
and Energy Management.

We would appreciate advice and opinions for industry on how we can better serve industry in the Energy Conservation Group of the Ministry of Industry and Tourism. Thank you.

"A GAS UTILITY'S VIEW OF DISTRICT HEATING"

Mr.G.E. Creber,
President, Consumers' Gas Co.

I was quite flattered to be given the opportunity to be here at this meeting and also somewhat concerned because I'm really probably the only speaker before you who isn't an expert on many or most of the technicalities that go into district heating. But perhaps I can present one gas utilities man's view of district heating, which may also be somewhat representative, but not necessarily completely so, of the industry itself.

I guess our first reaction when thinking of district heating is one of concern, as well as one of extreme interest. Perhaps to phrase it another way, our reaction is one of being challenged, but also one of having an opportunity as a result of that challenge. First, I might just give you some cautionary concerns that we as a gas utility and people who are selling energy to a large number of customers have when we listen to and look at and examine some of the facets of district heating. The traditional rationale for district heating seems to be based primarily on the following factors: energy conservation, cost per BTU of useful heating delivered, air quality, fuel flexibility, and safety.

Energy conservation -- I don't think anyone today challenges the desirability of conservation of energy at every level. The question for district heating is really, does district heating in fact contribute to conservation? The energy situation in which Canada and Ontario find themselves is quite different from that of Scandinavian countries which are often used as the model of district heating. Canada does have large amounts of energy in many forms. There was a reference to the potential shortage of gas from one of the speakers. At the present time, our current problem in the country would appear to be that we have a surplus that we cannot use in the domestic marketplace, which the industry, although it has been guilty of giving many wrong assumptions in the past, now seems to feel is going to go on for quite a considerable period of time. I would suggest that that's a factor which cannot be completely overlooked when we consider district heating. Now I think that it is a perfectly valid point of view for people in Ontario to recognize Ontario's vulnerability in all forms of energy need, because we produce very little, an inconsequential amount of gas or oil in the province. Therefore, I think it is quite legitimate for Ontario to look to reducing its dependence on that form of energy, because it must keep in mind, as Dr. Rowe has pointed out, that Ontario has been a secondary manufacturer for the country known as Canada.

I think Ontario would probably be shortsighted if it did not recognize the legitimate problems of Canada as a whole and attempt to solve the problems of Ontario within that framework. I would suggest to you that Ontario, with its heavy reliance on secondary manufacturing, probably stands to lose more than any other province of Canada if the present trend to balkanization of our country continues.

The progress which we have made in the efficient transformation of energy has been significant throughout the years and continues even today. Oil and gas burning appliances have been improved to the point where gas furnaces can be virtually as efficient as a central heating plant and are being improved. However, I think that the efficiency of central heating systems are going to improve too, and careful comparisons are going to have to be made as to which is the best possibility of efficient use.

This leads perhaps to the second point, and that is the cost per BTU delivered. To supply a given development project from a given district heating system rather than from individual units requires a significantly larger capital investment. Unless there is a very significant advantage in fuel burning efficiency or the price of the fuel purchased, the economic advantage of a district heating system may be questionable. In summary, I think a careful examination has

to be made at all times of the relative efficiency of competing kinds of fuel.

It will perhaps come as no surprise to you that we feel that even in district heating natural gas may well be an acceptable efficient use of fuel for that purpose. It has been suggested that district heating allows more future fuel flexibility than could be achieved by individual heating units. This is true, provided facilities to accommodate alternate fuels or energy sources have been incorporated into the design of the district heating plant. The incremental cost of such flexibility must, however, be borne by someone during the intervening years.

Perhaps in listening to the papers that were presented this morning the largest area of concern that hit me was not one that particularly affects me as a gas utility man, but as a person living in the province, and from the experience that I have had in the job that I now have in dealing with some 530,000 customers, and that is the very significant social impact of the scheme that is being advanced this morning. I don't think that the fact that it has such a social impact negates necessarily the desirability, but I think it does call for very careful examination of what it means and indeed, its acceptability by the consuming public.

To put district heating in perspective as it now stands, I did examine very quickly the paper called "The Nuclear District Heating Option - An Ontario Perspective", and it has a couple of paragraphs in there that I might just comment on. It quite properly points out the social, legal and administrative problems that district heating has and states that further development of the concept will undoubtedly require demonstration projects. In another paragraph, it does go on to state that electricity produced by the combined generation of electricity and hot water using small back pressure turbine generators which are compatible with district heating cannot now compete with electric power generated by Ontario and Ontario Hydro. In advancing these cautionary words, you might assume that I am negative towards district heating. In fact, I'm not. I advance those merely as cautionary words that very great care has to be undertaken with the projects to be developed.

I think that there is a very large likelihood that district heating does have a place in the future energy requirements of this province. We, as a utility, would like to see demonstration projects and pilot projects proceeded with so that how these concerns can be overcome and the relative economics of one form of energy use over another can be demonstrated and found out through practical application. We would, however, like to suggest that the private sector

has a place in such pilot projects. The place is not that we can do it more efficiently than anybody else, but merely a place that we can bring to such projects a different discipline, which married with the other disciplines, I think can produce the type of ultimate planning for district heating which would be desirable for the province.

CLOSING REMARKS

I.H. Rowe

Thank you, Mr. Creber. You've now been exposed to a wide spectrum of views on district heating and the applicability of other experience here in Ontario. Where do we go from here?

Our on-going program includes a number of studies of feasibility, institutional factors, technology development and financing options. Several reports that will be of interest are about to be published very shortly. These include two reports on the feasibility of a central distribution system for the St. Lawrence project in Toronto, one for the Sarnia downtown core and a trip report by John Hix on the urban planning aspects of district heating in Europe.

Meanwhile, we are also taking a hard look at the apparent barriers and de facto disincentives facing municipalities and the private sector with respect to district heating. We do not wish to minimize the problems we face; but commitment is needed now if we want to have some options open rather than being left holding an empty bag, an empty energy future, in 10 or 15 years time. Over the next year, as we gain a better understanding of the intricacies involved in getting district heating into the ground, we want to work constructively with municipalities to develop an appropriate regulatory, legislative, and financial framework.

In addition, there are certainly technology improvement and optimization activities that we intend to pursue in co-operation with the federal government. Reducing the cost and improving the reliability of district heating equipment are in the national interest. Following our initial work three years ago on the nuclear district heating option, our relationship with research and development efforts going on internationally has been excellent, and we intend to capitalize fully on what is learned elsewhere as well.

We see all of these activities as sowing the seed. With your continued interest and, most importantly, cross-dialogue between different professional groups, we look forward to the day in the not too distant future when a district heating system with equipment manufactured in Ontario will be constructed. That's what it's all about -- jobs, dollars, energy conservation, securing Ontario's energy future.

Now I'd like to open discussion to questions from the floor. I'd like to introduce the panel; feel free to ask questions of any one or more.

Bruce Richardson, H.H. Angus & Associates Ltd.

John Hix, Hix Associates Ltd.

Fred Molland, Ministry of Industry and Tourism

Peter Harper, Special Projects Co-ordinator-Planning,
Consumers' Gas Co.

Roy Waters, Process & Equipment Development Engineer,
Energy and Environmental Studies, Ontario Hydro

Bunli Yang, Adviser, Transportation and Urban Development,
Ministry of Energy.

Thank you.

PANEL DISCUSSION

Dr. Ian Rowe: I have a question I would like to address to John Hix because it is one that has bothered me over the years. What is the gross density that would make district heating work from an economic point of view, and is it going to be socially acceptable to the people of Ontario who are used to urban sprawl?

John Hix: Well, the charts that I referred to reflecting Scandinavian experience seem to show that densities consistent with low rise apartment buildings are sufficient for district heating. I tried to emphasize in my talk that geometric patterns are at least as important as overall density. We often speak rather simplistically about the density of buildings on land. I think there is a fundamental importance of the arrangement of buildings on land, so that it is quite feasible and possible to have some detached houses and townhouses to make district heating economically viable. I say this based upon some work that we have done with Shawinigan and Scanada, with the Cadillac Fairview project in South March. The idea there was to make a very rationalized layout of housing and to connect basements one to the other in so-called linked housing. It would be semi-detached housing because this is not Scandinavia -- this is Ontario. A Canadian has a specific dream about his relationship to nature and also his own piece of land. Consequently, my feeling is that density is a complicated issue. That is evading the question a little bit,

but I think there is a need for study in patterns of housing related to piping systems.

Ian McNaughton, McNaughton Planning Consultants:

I am with the town of Kincardine and our interest in this issue has been related to the Bruce Nuclear Project and using waste heat from the Bruce Nuclear Power Station. I was interested in John's answer because I think that is the nub of the issue that has to be addressed. We have to know if we can apply district heating economically to the type of densities that are going to continue in Ontario. We're not going to change drastically the consumer demand; we have to deal with what consumer demand is in terms of density. There has been a report published by the federal government -- I think it came out of the provincial work on the Pickering project -- which showed it was economical to district heat down to a small community size of 2,400 with a mix of detached and multiple units and an industrial component. So we have got some work now on the plate and I think we should perhaps get it out and make people aware of that kind of information.

Julian Reed: I'm the Energy Critic for the official Opposition in Ontario. I would like to ask if Ontario Hydro is prepared -- being possibly the largest potential supplier of energy for these projects -- to consider changing its expansion program and adapting it to this kind of end use. In other words, rather than to continue with proliferating the large centralized utilities which are very often removed from populated areas, would it now be prepared to consider

the kind of hybrid plants that might lend themselves more readily to this kind of energy organization?

Dr. Ian Rowe: That is also a question that the Royal Commission on Electric Power Planning is considering, too. Roy, your response for Ontario Hydro.

Roy Waters: I don't think that Ontario Hydro alone can answer that question. There is a one-word answer, of course, and it is yes. As Ian indicated in introducing me, Ontario Hydro has participated over the years in the district heating investigations and studies that have been carried out with regard to our generating plants. It is possible to draw heat from any of them right now. The answer to your question to whether we are prepared to participate in community planning such as Pickering, the answer is obviously yes, we've done that, and we are prepared to continue that in the future.

Stan Crust, Shaw Pipe Industries: I would like to ask a question pertinent to the statement that high density areas are a prerequisite in district heating. How does this relate to projects such as Woodroffe, Townsend and South March which are not necessarily high density projects?

John Hix: The report that I gave this morning was based on my observations in Scandinavia. I would say this -- that

the first district heating systems were installed in high density areas. It's obvious that this would be most economical. As the systems grew, there were, in fact, medium density areas possible to connect up with the system. On the other hand, in Scandinavia you see in suburban areas townhouse groupings which have a temporary boiler plant which they claim has a similar cost to having individual heating units in the houses themselves. Now the South March project I can speak of simply as being an approach in which we lay out the houses in such a way as to attempt to run the piping in basements. In other words, to have linked basements or short links between housing groups to essentially minimize these costs. I did not do the economic discussion on the South March project. I do not know anything about the Woodroffe project, but generally speaking, higher densities make the economics much easier. I think that's where the important studies are right now -- to validate the projects like South March which were in fact only put forward on a very preliminary basis. Right now, we need the next step of hard economic decision making on such densities. One of the key points here is, of course, affordable housing, too.

Dr. Bunli Yang: I wonder whether I could take a crack at that also. I don't think we should focus too strongly on this question of high versus low density while it is defin-

itely important. John has also indicated that geometric arrangement is also a key, but it is also the size of the load. In order to justify a central distribution system you are looking for a load of at least a certain critical size, let's say a minimum of 10 MW. That's about 30 million BTU per hour peak demand. If you can guarantee yourself that kind of load, whether it is a commercial centre or an industrial park or high density housing, then you can service, if the geometric arrangement is attractive, medium and low density housing in nearby environs. But it is the extent of the density of the pockets as well as the concentration of load. We have talked about high density because we're saying that if you really want to extend it to 15% of the Ontario population you might need higher densities. That may be true, but we're interested at the moment in getting the concept verified in the ground by pilot demonstrations. That means we are going to be looking for special circumstances that give us a high heat load level. It need not be high density housing.

Bob Sheppard, Fodor Engineering: I would like to ask a question that relates to your suggestion that a high density load created by a commercial installation with residential surrounding might be suitable for district heating. Obviously, there would be electrical generation involved in this. Where does the Hydro stand on a situation like this?

Dr. Bunli Yang: Well, Roy can answer this more directly than I, but generally speaking, of course, all these communities are serviced from the Ontario Hydro grid. Even the larger proposed developments -- let's say Mississauga City Centre -- that would take place over the next 20 or 30 years with large heat loads, the conventional way of development there would have all the electricity supplied from the Ontario Hydro grid. I don't know that I could speculate on the possibilities of back pressure generation for that local area, but there has been talk of waste incineration for Peel County, and that may be a possibility. These are engineering options that we should be looking into from a planning point of view today because even though the technology may be demonstrated elsewhere, we haven't considered them early enough in the planning of our development to incorporate them as realistic options.

Roy Waters: I'm not sure of the exact slant of your question, but after my return from the technology mission, I wrote a trip report. This was an internal report of my conclusions and observations, and I said that the role of the Ontario Hydro with respect to district heating could be similar to that of the state-owned electric utilities in Scandinavia. One, it provides a network for transmission and distribution of electric power throughout the province. Two, it could purchase electricity from combined heat and electricity generating plants and distribute it through the network. Three, it could be the part owner of combined heat

and electric stations along with the municipality and private shareholders. This would ensure that Ontario Hydro would share in the control of electrical production and planning and pricing, which is the practice in Scandinavia. I don't know if that's the thrust of your question or not.

Dr. Ian Rowe: Thank you, Roy. I would like to thank the panel for their participation. I would also like to acknowledge the cooperation of Consumers' Gas Company and Ontario Hydro in assisting in the development of energy conservation policy with respect to district heating. Thank you ladies and gentlemen for your interest in district heating. I look forward to hearing from you in the future.

Charge Slips - Technical Reports	
Publishing Body	<u>Mo Energy</u>
Report Number	<u>DISTRICT HEATING</u>
Title	<u>SEMINAR: Summary of</u> <u>District Heating in 1978</u>

RESOURCE CENTRE
INST. FOR ENVIORN'L. STUDIES
UNIVERSITY OF TORONTO



